Introduction

Many livestock facilities in the United States handle manure as liquids and slurries. Stored manure liquids and slurries decompose anaerobically (i.e., in the absence of oxygen) producing large volumes of gas. This gas is often referred to as biogas. Biogas contains between 60 and 80 percent methane (about 600-800 BTU/ft^3) and is considered a renewable energy resource.

Substantial opportunities exist across the country to recover and use biogas energy by adapting manure management practices to include biogas generation and collection. This handbook focuses on identifying and evaluating opportunities for recovering and utilizing this energy through the implementation of biogas technology.

This handbook is for livestock producers, developers, investors, and others in the agricultural and energy industry that may consider biogas technology as a livestock manure management option. The handbook provides a step-by-step method to determine whether a particular biogas recovery system is appropriate for a livestock facility. This handbook complements the guidance and other materials provided by the AgSTAR program to the development of biogas technologies at commercial farms in the United States.

The AgSTAR Program

The AgSTAR Program is a voluntary effort jointly sponsored by the U.S. Environmental Protection Agency, the U.S. Department of Agriculture, and the U.S. Department of Energy. The program encourages the use of biogas capture and utilization at animal feeding operations that manage manures as liquids and slurries. A biogas system reduces emissions of methane, a greenhouse gas, while achieving other environmental benefits. In addition, converting livestock wastes into an energy source may increase net farm income.

AgSTAR currently provides the following reports and tools to assist livestock producers and other interested parties in making informed business decisions about the financial and environmental performance of these technologies:

<u>General Information</u>

The AgSTAR Program - Managing Manure with Biogas Recovery Systems

AgSTAR Digest: an annual newsletter

Project Development Tools

AgSTAR Handbook: A Manual for Developing Biogas Systems at Commercial Farms in the United States

FarmWare: A pre-feasibility software package that accompanies the *AgSTAR Handbook*

Industry Directory for On-farm Biogas Recovery Systems: a listing of digester designers and equipment suppliers

Funding On-farm Biogas Recovery Systems: A Guide to National and State Funding Resources

Market Opportunities for Biogas Recovery Systems: A Guide to Identifying Candidates for On-farm and Centralized Systems

Environmental Performance

Dairy Cattle Manure Management: A Case Study of a Plug Flow Anaerobic Digestion System

Swine Manure Management: A Case Study of a Covered Lagoon Anaerobic Digestion System (under development)

Swine Manure: A Case Study of a Complete Mix Digester System (under development)

All these products are free of charge and can be downloaded at www.epa.gov/agstar.

Organization of this Handbook

This handbook is organized into chapters according to the process of biogas project development as presented in Exhibit 1. Chapter 1 provides an overview of the technology. The subsequent chapters lead you through two stages of project development. Supporting information is included in the appendices. The two stages of project development are:

I. Project Feasibility Assessment. Chapters 2, 3, and 4 provide guidance on screening for project opportunities, selecting a gas use option and conducting site-assessments to identify technically appropriate and cost-effective biogas recovery option(s).

II. Project Implementation. Chapters 5 through 8 discuss the steps to develop a biogas project. The steps include: securing an energy contract; selecting a developer; obtaining project financing; and complying with permitting requirements.

Exhibit 1 Project Development Process

I. PROJECT FEASIBILITY ASSESSMENT
Ch. 2 - Preliminary Screening for Project Opportunities
Ch. 3 - Selecting a Gas Use Option
Ch. 4 - Technical and Economic Feasibility Assessment

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II. PROJECT IMPLEMENTATION
Ch. 5 - Securing an Energy Contract
Ch. 6 - Selecting a Consultant/Developer/Partner
Ch. 7 - Obtaining Project Financing
Ch. 8 - Permitting and Other Regulatory Issues

Exhibit 2 summarizes how this handbook can be used to meet various objectives. The first column lists several common objectives and the second column lists the chapter to consult and key elements of that chapter.

Exhibit 2 How to use this Handbook - Quick Reference

OBJECTIVE	CHAPTER TO CONSULT
I WANT AN OVERVIEW OF BIOGAS TECHNOLOGY? • **W**hat is biogas technology? • **W**hy would I use biogas technology? • **H**ow successful has biogas technology been?	**1. Overview of Biogas Technology** 1.1 What is Biogas Technology? 1.2 Benefits of Biogas Technology 1.3 The U.S. Biogas Experience
Part I. Project Feasibility Assessment	
SHOULD I CONSIDER BIOGAS RECOVERY AS AN OPTION FOR MY LIVESTOCK FACILITY? • **H**ow do I know if my facility is ready to operate a biogas system? • **W**hat information do I need to identify promising opportunities for a biogas system? • **H**ow do I know if I have the skills and support to operate a biogas system?	**2. Preliminary Screening for Project Opportunities** 2.1 Is Your Facility "Large", with Animals in Confinement? 2.2 Is Your Manure Management Compatible with Biogas Technology? 2.3 Is there a Use for Energy? 2.4 Can You Manage the Farm Effectively? 2.5 Initial Appraisal Results
CAN I USE BIOGAS AT MY FACILITY ? • **W**hat are the main uses of biogas? • **H**ow do I determine which biogas utilization option will maximize economic return? • **W**hat are the electricity generation options? How do I determine which option is suitable for my facility?	**3. Selecting a Gas Use Option** 3.1 Electricity Generation 3.2 Direct Combustion 3.3 Other Options
IS A BIOGAS SYSTEM TECHNICALLY AND FINANCIALLY FEASIBLE FOR MY FACILITY ? • **H**ow do I decide which biogas technology is appropriate for my livestock facility? • **W**hat information do I need to evaluate the technical and economic feasibility of a biogas project? • **H**ow do I compare the costs and revenues from a biogas project?	**4. Technical and Economic Feasibility Assessment** 4.1 Match a Digester to Your Facility's Waste Management Practices 4.2 Complete Evaluation Sheets 4.3 Enter Information into FarmWare 4.4 Evaluate Results
Part II. Project Implementation	
HOW DO I CLOSE THE UTILITY DEAL? • **D**o I need a utility deal? • **H**ow do I know if I'm getting the best possible deal? • **H**ow do I negotiate a "win/win" deal? • **W**here do I get help?	**5. Securing an Energy Contract** 5.1 Operation Modes 5.2 Interconnection Requirements 5.3 Who to Contact 5.4 What to Ask for 5.5 Elements of and Agreement 5.6 Why Negotiate and What to Watch Out For 5.7 Future Possibilities for Selling Electricity

Introduction

OBJECTIVE	CHAPTER TO CONSULT
How Do I Select A Consultant/Developer/Partner? • How do I know whether I need a consultant/developer/partner? • What should I look for in a consultant/developer/partner? • What should I include in a contract?	**6. Selecting a Consultant/Developer/Partner** 6.1 The Do-it-Yourself/Turnkey Decision 6.2 Selecting a Consultant/Consulting Firm 6.3 Selecting a Turn-Key Developer 6.4 Selecting a Partner 6.5 Preparing a Contract
How Do I Get Financing For The Project? • What are the sources of funding for biogas projects? • What do lenders/investors look for? • How do I evaluate different financing options?	**7. Obtaining Project Financing** 7.1 Financing: What Lenders/Investors Look For 7.2 Financing Approaches 7.3 Capital Cost of Different Financing Alternatives
What Do I Need To Know About The Permitting Process? • What permits do I need? • How do I get these permits? • Do I need to worry about meeting air quality emission standards from IC engines?	**8. Permitting and Other Regulatory Issues** 8.1 The Permitting Process 8.2 Zoning and Permitting 8.3 Community Acceptance 8.4 Regulations Governing Air Emissions from Energy Recovery Systems
Where Are Biogas Systems Currently Operational?	**Appendix A:** http://www.epa.gov/agstar/projects/index.html
Where Can I Get A List Of NRCS And Other Key Contacts?	**Appendix B:** http://offices.sc.egov.usda.gov/locator/app?agency=nrcs **and** http://www1.eere.energy.gov/biomass/state_regional.html
Where Can I Get Help On Using Farmware?	**Appendix C:** FarmWare User's Manual - Version 3.4
Where Can I Get The NRCS Practice Standards?	**Appendix F:** NRCS Practice Standards
What Information Is Needed From The Utility For A Preliminary Feasibility Assessment?	**Appendix G:** Utility Letter of Request (Sample)
Where Can I See What Typical Utility Rate Schedules Look Like?	**Appendix H:** Utility Rate Schedules, Riders, and Interconnection Requirements (Samples)
Where Can I Get A List Of Developers And Equipment Suppliers?	**Appendix I:** List of Designers, Equipment Suppliers, and Vendors
Where Can I Get Definitions Of Technical Terms Mentioned In This Handbook?	**Glossary**